

CALIFORNIA DIVISION OF MINES AND GEOLOGY

FAULT EVALUATION REPORT FER-136

February 16, 1982

1. Name of fault

Vaca-Montezuma Hills fault zone, Rio Vista fault.

2. Location of fault

Denverton, Elmira, Mt. Vaca, Rio Vista, Jersey Island, and Honker Bay 7.5-minute quadrangles, Solano County (figure 1).

3. Reason for evaluation

Part of 10-year fault evaluation program (Hart, 1980).

4. List of references

Atwater, B., 1979, Generalized geologic map of the Rio Vista 15-minute quadrangle, California: U.S. Geological Survey Open-file Report 79-853, scale 1:62,500.

Bailey, T.L., 1930, The geology of the Potrero Hills and Vacaville region, Solano County, California: University of California Publications in Geological Sciences, v. 19, p. 321-334.

Burke, D.B. and Helley, E.J., 1973, Map showing evidence for recent fault activity in the vicinity of Antioch, Contra Costa County, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-533, scale 1:24,000.

Earth Sciences Associates, 1973, Preliminary report on the geology and seismicity of the southwestern Montezuma Hills and vicinity: unpublished consulting report for P.G. & E.

Emerson, D.O. and Roberts, R.D., 1962, Geologic map of Putah Creek, in Bowen, O.E., Jr., (ed.), Geologic Guide to the gas and oil fields of Northern California: California Division of Mines and Geology Bulletin 181, Map Sheet 3.

- Hart, E.W., 1980, Fault-rupture hazard zones in California: California Division of Mines and Geology Special Publication 42, 25p.
- Helley, E.J. and Herd, D.G., 1977, Map showing faults with Quaternary displacement, northeastern San Francisco Bay Region, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-881, scale 1:125,000.
- Knuepfer, P.L., 1977, Geomorphic investigations of the Vaca and Antioch fault systems, Solano and Contra Costa Counties, California: Stanford University, California, unpublished M.S. thesis, 53 p., Pl. 1-7.
- Pampeyan, E.H., 1979, Preliminary map showing recency of faulting in north-central California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1070, scale 1:250,000.
- Reiche, P., 1950, Rio Vista, California, fault scarp (abstract): Geological Society of America Bulletin, v.61, p. 1529-1530.
- Sims, J.D., Fox, K.F., Jr., Bartow, J.A., and Helley, E.J., 1973, Preliminary geologic map of Solano County and parts of Napa, Contra Costa, Marin, and Yolo Counties, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-484, scale 1:62,500.
- U.S. Geological Survey, 1974, Aerial photos GS-VDMW 1-30 to 32, 37 to 39, 60-62, black and white, vertical, scale approximately 1:36,000.
- U.S. Geological Survey, 1974, Aerial photos ^{SFA} 10-35 to 45, 58-64, 11-5 to 11, low sun angle, color, vertical, scale approximately 1: 36,000.

5. Review of available data and air photo interpretation.

A discontinuous, northwest-trending zone of faults located between Vacaville and the Sacramento River will be informally referred to in this FER as the Vaca-Montezuma Hills fault zone (figure 1). Knuepfer (1977) studied this discontinuous zone of faults and, for purposes of discussion, divided the fault zone into the Vaca Mountains, Vacaville, Cannon Hills, Kirby Hill, and Montezuma Hills segments. Knuepfer's nomenclature will be used in this FER.

The Vaca-Montezuma Hills fault zone is located generally along the east-facing slopes of the Vaca Mountains in the northern part of the study area and along the west-facing slopes of the Montezuma Hills in the southern part of the study area. The magnitude and sense of displacement along the Vaca-Montezuma Hills fault zone is not known, although the generally linear scarps, deflected drainages, and fault exposures suggest a steeply-dipping fault plane with predominantly strike-slip displacement. Land surfaces along the fault zone have been modified by development in the Vacaville area. Agricultural use has modified land surfaces to some extent along most of the fault zone.

VACA MOUNTAINS SEGMENT

The Vaca Mountains segment of the Vaca-Montezuma Hills fault zone was originally mapped by Bailey (1930) along the northeast-facing slopes of the Vaca Mountains north-northwest of Vacaville (figure 2). The Vaca Mountains segment is characterized principally by aligned saddles along a N20°W trend (figure 2). Knuepfer (1977) investigated this feature by air photo interpretation and detailed field checking. He concluded that differential erosion along bedding planes ^{striking} ~~which strike~~ parallel to the inferred fault of Bailey, rather than faulting, was more compatible with the observed geomorphic evidence (figure 2). Knuepfer reports that shale beds mapped by Emerson and Roberts (1962) correspond in location with Bailey's Vaca Mountains fault.

Sims, et al (1973) and Helley and Herd (1977) do not map the Vaca Mountains fault. Pampeyan (1979) depicts the fault as concealed by alluvium (figure 1).

The interpretation of differential erosion along bedding planes seems more compatible with the observed geomorphic features, based on brief air photo interpretation by this writer (figure 2). Structural continuity can be observed across the mapped trace of the Vaca Mountains segment.

VACAVILLE SEGMENT

Knuepfer (1977) maps an inferred north-northwest-trending fault along the west slope of the English Hills (figures 1, 3). This inferred fault is based on the linearity of the west slope of the English Hills and on the linearity of Ulatis Creek (figure 3). The inferred fault strikes parallel to beds of the Eocene Markely Sandstone (Sims, et al, 1973). No geomorphic evidence of faulting in addition to the linearity of the English Hills and Ulatis Creek was observed by Knuepfer (1977) (figure 3). The oversteeping of the west-facing slope within the city limits of Vacaville may be due to faulting, but lateral erosion along the course of Ulatis Creek is an equally compelling explanation. Knuepfer states that there is no conclusive evidence supporting the location of a fault along the west side of the English Hills. Sims, et al (1973), Helley and Herd (1977), and Pampeyan (1979) do not map the Vacaville fault.

CANNON HILLS SEGMENT

The Cannon Hills fault segment will be divided into the northern and southern sections for purposes of discussion in this FER (figures 4a, 4b).

The northern section of the Cannon Hills segment was first mapped by Bailey (1930), who depicted the fault as concealed under alluvium. Knuepfer (1977) maps this fault along the base of the east-facing slope of the Cannon Hills (figure 4a). Pampeyan (1979) maps this feature as queried and concealed. Helley and Herd (1977) do not map this fault.

Knuepfer (1977) maps the northern section of the Cannon Hills fault based on the linearity of the Cannon Hills and the predominantly right-lateral deflection of the drainages crossing the fault (figure 4a). Although a number of drainages are right-laterally deflected, there is no systematic style or magnitude of offset. There is no corresponding drag or deflection of ridges associated with the mapped trace of the fault, and the drainage channels west of the fault are not deflected in a right-lateral sense as one would expect for an active strike-slip fault (figure 4a). Additional drainage channels away from the mapped trace of the northern section of the Cannon Hills fault are also deflected, mainly at or near the head of alluvial fans. Most of the drainage deflections along the fault trace observed by this writer also occur at or near the head of alluvial fans, suggesting that processes other than faulting may have caused the deflections.

Incised alluvial fans that cross the trace of the fault are not offset (Knuepfer, 1977). No geomorphic evidence of recent faulting was observed in areas underlain by alluvium north and south of the mapped trace of the northern section of the Cannon Hills fault (Knuepfer, 1977; figure 4a).

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Knuepfer concludes that features along the eastern slope of the Cannon Hills are probably formed by faulting. Geomorphic evidence for recent faulting along this fault segment is limited to a number of predominantly right-lateral deflected drainages. Because additional geomorphic evidence associated with these drainages was not observed and recent alluvium is not offset along the fault trace, Knuepfer concludes that the northern section of the Cannon Hills fault is probably not active.

The southern section of the Cannon Hills fault, originally mapped by Bailey (1930), is delineated by a linear trough (in bedrock) along a northwest trend north of the Southern Pacific Railroad. South of the railroad the fault is delineated by a linear valley. The fault offsets Cretaceous age shale against Eocene Domengine Sandstone (Knuepfer, 1977; figure 4b). Geomorphic features associated with the trough, such as closed depressions and vegetation contrasts, are permissive of Holocene faulting, but geomorphic evidence of recent faulting in alluvium northwest and southeast of the trough was not observed by Knuepfer or this writer (figure 4b). Knuepfer concludes that differential erosion along a bedrock fault, rather than recently active faulting, formed the features within the trough and along the trend of Union Creek Valley.

Helley and Herd (1977) do not map the Cannon Hills fault. Pampeyan (1979) maps the Cannon Hills fault in bedrock, but depicts the fault as concealed by alluvium northwest and southeast of the trough in bedrock.

KIRBY HILL SEGMENT

Two sub-parallel fault traces east of Kirby Hill are mapped by Knuepfer (1977) (figure 5). Sims, et al (1973) map a fault in Kirby Hill

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along a similar trend near the gas well road, but project the trace more to the south. Farther south along the trend of this western branch, Knuepfer and Sims, et al generally agree on the location of the fault (figure 5).

No geomorphic evidence of recent faulting was observed by Knuepfer or this writer along the west branch of the Kirby Hill fault (figure 5). Sims, et al map this fault segment as concealed by alluvium.

The east branch of the Kirby Hill fault is exposed in a gravel pit east of Kirby Hill, where Eocene Markeley Sandstone is offset against conglomerate of the Pliocene Tehama^a Formation (Knuepfer, 1977; figure 5). Southeast of the gravel pit the fault is delineated by a vague soil contrast (figure 5). Geomorphic evidence of recent faulting was not observed along the trace of the east branch of the Kirby Hill fault (Knuepfer, 1977). The soil contrast is probably due to the development of residual soil from contrasting parent lithologies rather than soil offset by recent faulting.

MONTEZUMA HILLS SEGMENT

The western slope of the Montezuma Hills is a fairly linear escarpment and was considered to be a fault by Reiche (1950) and Burke and Holley (1973). Knuepfer (1977) did not observe geomorphic evidence of recent faulting along the western hill front. Specifically, there are no offset drainages across the trace of the fault, the escarpment is not linear in detail, and the contact between the Pleistocene Montezuma Formation and alluvium is not consistently found along the scarp (Knuepfer, 1977; figure 6). The west-facing escarpment is less steep than some erosional slopes within the Montezuma Hills (Knuepfer, 1977).

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Knuepfer concludes that "...available evidence seems to suggest that the west front of the Montezuma Hills was not caused by faulting, although the geomorphic evidence in itself is not conclusive. A more likely explanation is that the scarp is a remnant reflection of an abandoned and buried Pleistocene meander of the Sacramento River."

This interpretation of an erosional origin of the west-facing escarpment along the western Montezuma Hills is supported by an Earth Sciences Associates investigation in 1973. Geophysical methods (seismic refraction, electrical resistivity, gravity), borhole, and trench excavations indicated "... that the escarpment is of erosional origin, and that beneath its relatively smooth surface is a buried complex of two or more terrace benches backed by steep buttress-like unconformities between truncated strata of the Montezuma Formation and several sequences of younger alluvial and colluvial deposits. The successive unconformities are complicated locally by younger slump masses and associated downward displacements, backward rotation, pull-away features, and slip surfaces. The erosion surface beneath the lowest and most widespread terrace lies at about Elevation 0, and it is covered by 50 to nearly 100 feet of alluvial and colluvial deposits. Pleistocene river channels are buried at still greater depths beneath the present river and slough areas adjacent to the southwest margin of the Montezuma Hills " (ESA, 1973).

RIO VISTA FAULT

The Rio Vista fault of Reiche (1950) is a northeast-trending feature located just south of Rio Vista (figure 7). The Rio Vista fault is characterized by a linear east southeast-facing escarpment in Pleistocene

Montezuma Formation (Sims, et al, 1973). There is no evidence of Holocene offset, based on mapping by Pampeyan (1979). Atwater (1979) does not map the Rio Vista fault and Helley and Hord (1977) did not observe evidence of offset along the Rio Vista fault.

The east southeast-facing escarpment has been extensively modified by man. Drainages that cross the trace of the Rio Vista fault exhibit no evidence of lateral or vertical offset, based on brief air photo interpretation by this writer (figure 7). It is probable that the Rio Vista scarp is formed by faulting, but lateral cutting by the Sacramento River, followed by deposition of floodplain or levee deposits, has enhanced the youthful appearance of the Rio Vista fault.

6. Conclusions

The Vaca-Montezuma Hills fault zone is a generally northwest-trending zone of discontinuous faults. Displacement along the fault zone is presumed to be primarily strike-slip, based on the linear fault traces and deflected drainages, although the ²sense and magnitude of offset is not known. The Vaca-Montezuma Hills fault zone is divided into the Vaca Mountains, Vacaville, Cannon Hills, Kirby Hill, and Montezuma Hills segments (Knuepfer, 1977). The linear, east-facing hill front and the predominantly right-lateral deflection of drainages was interpreted by Knuepfer as evidence permissive of Holocene faulting. However, the lack of geomorphic evidence of recent faulting in alluvium north and south of the bedrock fault location, the lack of fault-related geomorphic features associated with the deflected drainages, and the non-systematic deflection of drainages crossing the

mapped fault trace indicate that additional processes other than recent faulting should be considered (Knuepfer, 1977; Bryant, this report).

Knuepfer (1977) does not consider the Vaca Mountains, Vacaville, and Montezuma Hills segments to be faults. A site investigation for P.G. & E. conducted by Earth Sciences Associates (1973) in the southern part of the Montezuma Hills lineament exposed evidence of at least two river-cut terraces and associated fluvial deposits. Both Knuepfer and Earth Sciences Associates concluded that the linear escarpment along the western slope of the Montezuma Hills is erosional rather than the result of recent faulting.

Moderately well-defined segments of the Vaca-Montezuma Hills fault zone are generally confined to areas of Cretaceous and Tertiary bedrock. There is no evidence of faulting where traces of the fault zone are mapped in alluvium.

There is no geomorphic evidence of Holocene faulting along the Rio Vista fault of Reiche (1950). Pampeyan (1979) depicts this fault as active during late-Pleistocene time, but did not observe evidence of Holocene activity.

7. Recommendations

Recommendations for zoning faults for special studies are based on the criteria of "sufficiently-active" and "well-defined" (Hart, 1980).

Do not zone traces of the Vaca-Montezuma Hills fault zone described by Knuepfer (1977). These faults are not sufficiently active and most are not well-defined.

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Do not zone the Rio Vista fault of Reiche (1950). This fault is not sufficiently active.

8. Report prepared by William A. Bryant, 2-16-81.

William A. Bryant

*I agree with
recommendations,
based on data
presented.
GHA
5/13/82*